FARM MANAGEMENT *facts*

Making $ense of Salinity

QUICK FACTS ABOUT SALINITY

- **Salinity affects more than 600,000 acres in agricultural Saskatchewan.**
- **Salts occurs naturally in subsoils.**
- **High groundwater in discharge areas brings salts to the soil's surface and salinity becomes evident when water evaporates.**
- **Saline soils are usually fertile, but salts interfere with the ability of plants to absorb nutrients and moisture.**
- **Before implementing water management plans, it is important to identify the groundwater flows, water table levels and salt origins of the area.**
- **Growing vegetation, especially forage, is an effective management tool for saline lands. Forage areas can easily become part of the surrounding uplands.**

THE NATURE OF SALINITY

In well-drained soils, salinity does not appear, as precipitation and runoff leaches soluble salts past the root zone into the groundwater. Salinity becomes a problem when there is a high water table and salts are translocated to the surface. The water with the salts reappears at the surface and evaporates, leaving a white crusting on top of the soil. In many cases, salinity is generally localized, affecting only part of the field. This grevish-white salinity residue is comprised of mostly sodium, calcium and magnesium sulfates. Although harmless while deep in the ground, abundant salt near or on the soil's surface prevents plant roots from absorbing the water and nutrients required for plant life and growth.

Salinity in cultivated lands reduces productivity and concentrations of salt will increase over time so that eventually, only a limited number of crops will grow there. If left unmanaged, salinity will spread and the area of land affected will increase.

Although salinity will not disappear, effective water management can reduce or stop the spread of salts up to and across the soil's surface. One of the most effective tools in reducing salinity is the conversion of affected land to deep-rooted and salt-tolerant perennial vegetation. These areas can be managed with the surrounding uplands to provide an economic return from an area where productivity from annual crops is low. Income may be derived from pasture for late season grazing or from hay production.

FARM MANAGEMENT *facts*

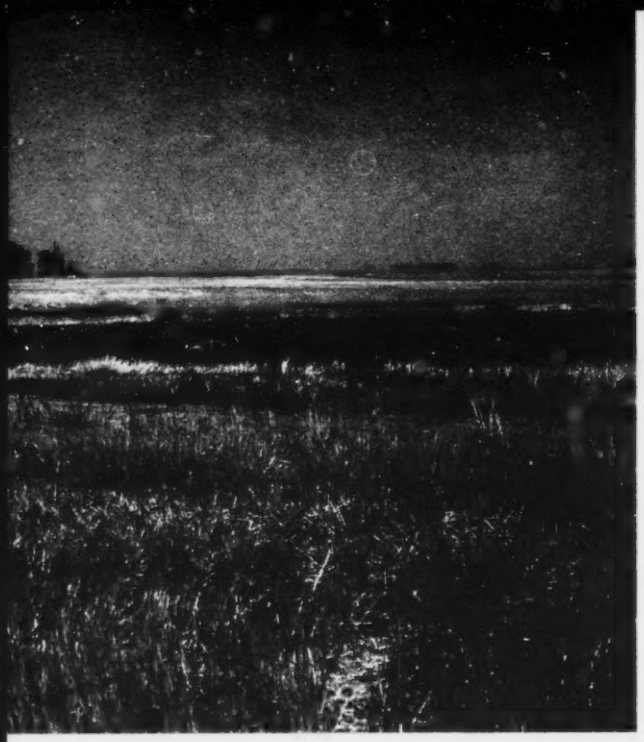
Making $ense of Salinity

THE NATURE OF SALINITY

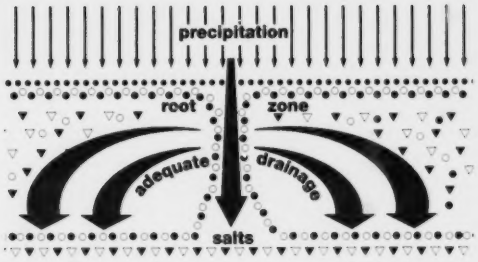
In well-drained soils, salinity does not appear, as precipitation and runoff leaches soluble salts past the root zone into the groundwater. Salinity becomes a problem when there is a high water table and salts are translocated to the surface. The water with the salts reappears at the surface and evaporates, leaving a white crusting on top of the soil. In many cases, salinity is generally localized, affecting only part of the field. This greyish-white salinity residue is comprised of mostly sodium, calcium and magnesium sulfates. Although harmless while deep in the ground, abundant salt near or on the soil's surface prevents plant roots from absorbing the water and nutrients required for plant life and growth.

Salinity in cultivated lands reduces productivity and concentrations of salt will increase over time so that eventually, only a limited number of crops will grow there. If left unmanaged, salinity will spread and the area of land affected will increase.

Although salinity will not disappear, effective water management can reduce or stop the spread of salts up to and across the soil's surface. One of the most effective tools in reducing salinity is the conversion of affected land to deep-rooted and salt-tolerant perennial vegetation. These areas can be managed with the surrounding uplands to provide an economic return from an area where productivity from annual crops is low. Income may be derived from pasture for late season grazing or from hay production.



Salinity is nothing new. The great plains of North America developed over a saline marine shale bed. Salts occur naturally in the soil and are common to most arid and semi-arid regions like the prairies.



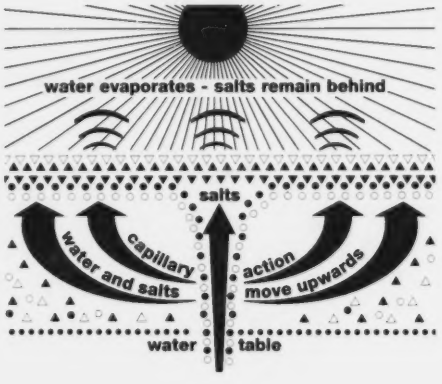
Adequate drainage reduces salinity by leaching soluble salts down through the root zone.

FACTORS THAT INFLUENCE SALINE CONDITIONS

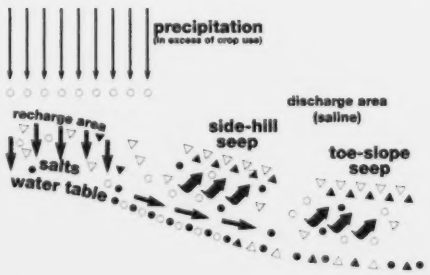
- *Water table level.* Higher water tables are more prone to salinity.
- *Groundwater flow.* Groundwater will move water soluble salts laterally to a discharge area.
- *Environmental conditions.* Warm temperatures, low humidity and wind increase evaporation.
- *Soil texture.* There is greater chance of salinity moving upward where soil is heavier in texture.
- *Vegetation at areas of discharge.* Greater vegetative cover in these areas reduces the effect of salinity.
- *Summerfallowing.* In recharge areas summerfallowing promotes the downward leaching of salts into the groundwater.

Sometimes the word "alkaline" is used to describe salinity, but alkaline soils don't always have a high concentration of soluble salt. Instead, alkaline soils have a high pH (over 8.5) and a high proportion of sodium. Alkaline inhibits plant growth and needs to be managed differently.

A high water table in a discharge area brings salts to the soil's surface and salinity becomes evident when the water evaporates.



Groundwater recharge and discharge areas can be a fair distance apart, so the movement of salts through the groundwater can be more regional than local in area.



SYMPTOMS OF SALINITY

- "Bathtub ring" around sloughs or wetlands.
- Patchy appearance of crops in the same field.
- Crop yields are low and plant growth is stunted.
- Barley is the most salt tolerant annual crop. If it fails to grow, management needs to be implemented to reduce the level of salinity.
- Plants affected by salinity have a bluish-green appearance. Some plants are more tolerant of salinity than others.
- Common halophytes (salt-tolerant plants) on cultivated lands include Russian thistle, kochia, foxtail barley and goosefoot plant species. When the area is converted to forages, these species may persist. Red samphire, salt grass, Nuttall's salt-meadow grass and greasewood are common halophytes on uncultivated land.

ECONOMICS OF CONVERTING CULTIVATED LANDS AFFECTED BY SALINITY TO PERENNIAL FORAGES

When barley is the only crop that grows on saline lands, or when bare soils appear in seeded areas or kochia is common, yields are reduced to less than 50 per cent of their potential yield. If annual cropping continues, salinity will spread, further reducing the yield. One of the most effective management tools for controlling salinity is to convert the affected field to perennial forages. Income can be obtained by either incorporating the newly seeded field into pasture or by producing a hay or silage crop.

The following worksheet outlines the primary costs of:

- growing barley on saline lands;
- producing forage on saline lands.

The sample figures, which are averages of Saskatchewan agricultural lands, are from the latest *Cost of Producing Grain Crops in Saskatchewan,* a Saskatchewan Agriculture and Food publication. These worksheets enable producers to compare the costs of various cropping practices on their saline lands.

A saline margin along the edge of a small wetland in Saskatchewan.

Points to consider when using this worksheet:

- No two farms are identical. Each farm has a different resource base (physical and economic), climatic conditions, land base, and location. Therefore, worksheet costs are unique to each producer as they must be based on a specific farming operation. When using this worksheet, base your actual farm costs and income on your experiences, as costs vary with management style.

Salinity is generally localized, affecting only part of a field.

- Crop markets vary and have a strong influence on cropping economics.
- Completing the worksheet will be useful to the land manager as a tool for planning and record keeping.
- Recent changes to grain transportation and other agricultural policies have altered the profitability of growing crops on some lands. Crops or rotations which were profitable may not be profitable now.
- Long-term benefits from converting land to forages in the form of soil improvement and production stability are not easily quantified.

Assumptions of these examples:

- Figures are based on barley grown on stubble in the dark brown soil zone.
- The "sample" area contains moderate (EC = 8mmhos) salinity, which reduces annual crop yield by about 50 per cent.
- Figures are based on land being converted to alfalfa and sold as hay (one tonne/acre; $60/tonne). No fertilizers or weed control have been included in the conversion to forages. Annual weeds can be controlled with the first hay cut.
- Figures are based on land being converted to a tall wheatgrass and slender wheatgrass mix and incorporated into a pasture system (stocking rate: 0.50 animal unit months/acre; average daily gain: 2 lbs/day; 600 lb steers are purchased at $0.95/lb and sold at 800 lbs for $0.90/lb).
- Cost of converting land to forages is averaged over a ten year period.
- Hired labour is not required or included in the "sample" cost analysis.
- The land manager has adequate capital assets to carry out the operation.

ANNUAL CROPPING OF BARLEY ON SALINE LANDS

	SAMPLE - BARLEY	ACTUAL
Income	24bu/acre @ $2.06/bu	
Total income per acre	$ 49.44	
Expenses		
- Seed	$ 4.23	
- Fertilizer	12.21	
- Pesticides	5.88	
- Fuel	6.48	
- Machinery repair	5.95	
- Taxes	3.47	
- Interest on operating loan	1.62	
Expenses per acre	$ 39.84	
Return to labour, land, insurance and investment	$ 9.60	

PERENNIAL FORAGES ON SALINE LANDS

	SAMPLE - ALFALFA	SAMPLE - PASTURE	ACTUAL
Income - Sale of hay	1 tonne/ac @ $60.00/t		
- Sale of steers		35-800lb @ 0.90/lb	
Total income per acre	$ 60.00	$ 157.50	
Expenses per year			
- Seed	2.60	1.10	
- Seeding costs	1.20	1.20	
- Fuel	3.24		
- Twine	1.34		
- Purchase of steers		124.68	
- Machinery repair	2.97		
- Fencing/dugout		5.63	
- Taxes	3.47	3.47	
- Interest on loans	3.80	12.56	
Expenses per acre	$ 18.62	$ 148.64	
Return to labour, land, insurance and investment	$ 41.38	$ 8.86	

Mulches of manure and straw worked into topsoil improve crop growth by reducing evaporation and salt concentrations at the soil's surface. Remember that neither fertilizers nor manure remove salts from the soil or neutralize saline soil.

MANAGEMENT OF SALINITY

- **E**ffective water management is the most important factor in controlling and managing salinity. This should be done at the landscape level. Practices that reduce water reaching the water table in recharge areas and that would limit upward movement and evaporation of water in the discharge areas should help to minimize the condition of salinity.
- **R**etain a border of perennial vegetation at least 10 metres wide around the water's edge of wetlands or sloughs. The "bathtub ring" of salinity around some sloughs often comes from cultivating too close to the water and destroying the vegetation that stops salt from reaching the surface. This also encourages the downward leaching of accumulated soil salts so the soil beneath reclaims the salt. The salt concentration in the top 30 cm may decline dramatically.
- **A**rrange for soil testing of your land by contacting a provincial soil conservation specialist. Soil testing determines the severity of salinity and the specialist can assist you in choosing techniques that will most effectively manage the salinity on your lands.
- **S**elect salt tolerant crops when annual cropping.
- **P**ractise shallow tillage by using low-lift shovels on your cultivator or rod-weeder. Deep tillage disturbs concentrations of salts in the subsoil region, bringing them to the surface.
- **A**void leaving the soil bare, as this encourages evaporation and salt accumulation on the soil's surface. Fallowing or planting salt-intolerant annual crops generally results in poor yields and the spread of salts. Cultivate saline lands only when necessary.
- **C**onsider alternatives to summerfallowing, including green manuring, continuous cropping, minimum tillage and forages in the crop rotation. Although it is difficult to control salinity through cropping techniques, it may be beneficial to seed directly into standing crop stubble.
- **F**ertilize according to recommendations from soil tests. High chemical fertilization may actually reduce yields in saline soils.
- **S**pread manure on saline soils to improve the organic matter content, nutrient levels and soil structure.
- **R**evegetate with perennial forages when annual cropping is not environmentally or economically sustainable. Germination of forages will be the greatest when moisture conditions are high and salt concentrations are low, but it is difficult to get machinery on the land at this time. The best seeding time is late fall to take advantage of good moisture in the spring.
- **P**lan for fall grazing in saline areas. These areas usually have poor soil structure and are susceptible to damage earlier in the season. The incidence of foot rot will also be higher when grazing occurs on wetter soils.

FORAGE CROPS RECOMMENDED FOR SALINE LANDS IN SASKATCHEWAN

When recommending forages for saline areas it is important to consider salinity concentrations, moisture levels and use of the crop. As a general rule, barley is the most salt-tolerant annual crop to grow in Saskatchewan. Tall wheatgrass and Rangelander alfalfa are the most saline-adapted grass and legume available at this time, but Altai Wildrye, Russian Wildrye, slender wheatgrass and crested wheatgrass may also grow well in saline areas.

- Selection of forage species for saline areas should be based on soil tests and should consider the planned use such as haying or grazing.
- Deep-rooted varieties are recommended for recharge areas as these species use a large amount of moisture, preventing it from reaching the water table.
- Seed a mixture of forage species to cover the range of salinity and moisture levels usually encountered in the saline areas.
- Altai wildrye and tall wheatgrass are the most tolerant grasses available for field-scale seeding.
- Slender wheatgrass does better in the drier soils whereas tall wheatgrass requires greater moisture levels.
- Russian wildrye and/or alfalfa should provide good fall pasture.
- Altai wildrye is highly suitable for fall and winter grazing.
- Proper weed control is essential to successfully establish and produce a forage stand.

Consult the *Saskatchewan Forage Crop Production Guide (1997)* for the most recent recommendations on seeding forages on saline soils.

Selective grazing near Meacham, Saskatchewan.

This document was developed and funded by the Saskatchewan Grazing and Pasture Technology Program and the Saskatchewan Wetland Conservation Corporation in conjunction with Ducks Unlimited Canada. More copies of this fact sheet or other *Farm Management Facts* are available from the Saskatchewan Wetland Conservation Corporation. (Tel: 306-787-0170)

Contributions to this *Farm Management Facts* are gratefully acknowledged:

Agriculture and Agri-Food Canada
Ducks Unlimited Canada
Prairie Farm Rehabilitation Administration
Saskatchewan Agriculture and Food
Saskatchewan Grazing and Pasture Technology Program
Saskatchewan Wetland Conservation Corporation
Soil Science Department, University of Saskatchewan
Wheatland Conservation Area Inc.

FURTHER READING:

The Nature and Management of Salt-Affected Land in Saskatchewan.
Saskatchewan Agriculture, Soils and Crops Branch.

Soil Salinity: A study in crop tolerances and cropping practice.
Saskatchewan Agriculture and Food.

Soil Improvement with Legumes.
Saskatchewan Agriculture and Food.

Saskatchewan Forage Crop Guide 1997.
Saskatchewan Agriculture and Food.

Forage Establishment: Getting it to Grow.
Ducks Unlimited Canada and PFRA.

Crop Protection Guide 1997.
Saskatchewan Agriculture and Food.

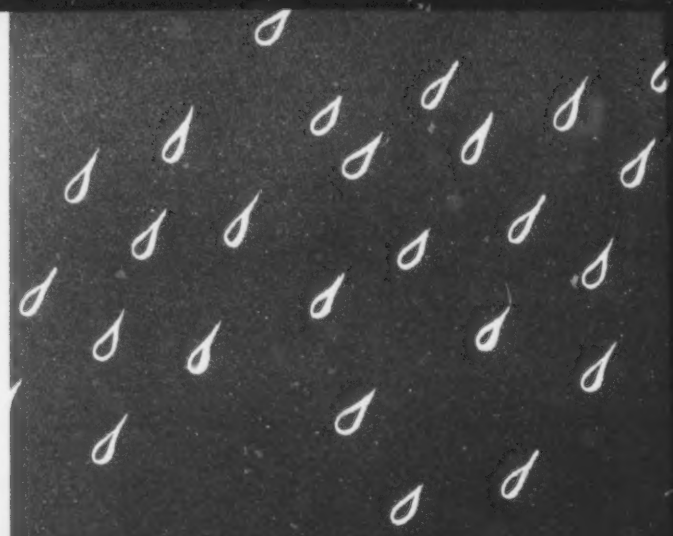
Field Guide: Identification of Common Range Plants of Southern Saskatchewan.
Saskatchewan Agriculture and Food.

Saskatchewan Wetland Conservation Corporation

GRAZING AND PASTURE TECHNOLOGY PROGRAM
Canada - Saskatchewan Agriculture Green Plan Agreement

Ducks Unlimited Canada

ISBN# | 896793-13-4 3/97 5M Printed in Canada



This document was developed and funded by the Saskatchewan Grazing and Pasture Technology Program and the Saskatchewan Wetland Conservation Corporation in conjunction with Ducks Unlimited Canada. More copies of this fact sheet or other *Farm Management Facts* are available from the Saskatchewan Wetland Conservation Corporation. (Tel: 306-787-0726)

Contributions to this *Farm Management Facts* are gratefully acknowledged.

Agriculture and Agri-Food Canada
Ducks Unlimited Canada
Prairie Farm Rehabilitation Administration
Saskatchewan Agriculture and Food
Saskatchewan Grazing and Pasture Technology Program
Saskatchewan Wetland Conservation Corporation
Soil Science Department, University of Saskatchewan
Wheatland Conservation Area Inc.

Saskatchewan Wetland Conservation Corporation

GRAZING AND PASTURE TECHNOLOGY PROGRAM

Canada - Saskatchewan Agriculture Green Plan Agreement

Ducks Unlimited Canada

ISBN# 1-896793-13-4 3/97 5M Printed in Canada